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SEWER ASSESSMENT PRACTICE IN MASSACHUSETTS

PAUL F. HOWARD,* MEMBER

(Presented at a meeting of the Sanitary Section of the Boston Society of Civil Engineers, March 1, 1933)

THE laws of the Commonwealth of Massachusetts provide in general that each person in a municipality receiving a benefit derived from the construction of a sewer therein shall pay for the same in proportion, as near as possible, to the amount benefited.

The laws provide that the expense of constructing and maintaining a system of common drains or main sewers may be divided in proportion to the following three benefits, and that the division of benefits must include the first two.

I. GENERAL BENEFIT

The general benefit is the benefit to the municipality as a whole, and is assessed by means of the general tax levy.

In a municipality which has sewers, a person who lives in the outlying districts of the municipality, where sewers will probably not be constructed for many years, will be benefited by the generally improved health conditions of the town, the improved sanitary conditions of the schools, churches, clubs, etc., used by his family, the increased property values of the portions enjoying the sewers, the availability of safer waterway for recreation, and the increased desirability of the town, both as a residential and manufacturing community.

The authority for this assessment is chapter 83, section 23, of the General Laws, — "any city except Boston and any town adopting a

* Of Whitman & Howard, 89 Broad Street, Boston, Mass.

system of sewerage which has not, prior to May sixth, eighteen hundred and ninety-two, actually levied assessments for the cost of such system shall pay such portion, not less than one quarter nor more than two thirds, of the cost of laying out, constructing, maintaining and repairing the common sewers as the city council or the sewer commissioners, selectmen or road commissioners may determine."

II. Specific Benefit

The specific benefit is the benefit to a person where a sewer is completed and is charged for by means of a direct assessment on the abutter or by an entrance fee.

> When a sewer is constructed in a way passing a person's land, his property receives another benefit or increase in value for building purposes, and the health conditions of his vicinity are further improved.

The authority for this assessment is chapter 83, sections 14 and 17, of the General Laws.

Section 14. A person who enters his particular drain into a main drain or common sewer, or who by more remote means receives benefit thereby for draining his land or buildings, shall pay to the town a proportional part of the charge of making and repairing the same, and of the charge, not already assessed, of making and repairing other main drains and common sewers through which the same discharges, which shall be ascertained, assessed and certified by the aldermen, sewer commissioners, selectmen or road commissioners.

Section 17. The aldermen of any city except Boston or a town in which main drains or common sewers are laid may determine that a person who uses such main drains or common sewers in any manner, instead of paying an assessment under section fourteen, shall pay for the permanent privilege of his estate such reasonable amount as the aldermen or the sewer commissioners, selectmen or road commissioners shall determine.

III. Annual Benefit

The annual benefit is the benefit to one who enjoys the use of the sewer and is assessed on a rental basis based directly or indirectly upon the amount of sewage contributed. If not assessed in this manner, the annual cost must be met from funds raised by means of the general tax levy.

> When a house is connected with a sewer the owner receives another and larger benefit because of the fact that the sewer is in actual use and because the municipality agrees to take care of the disposal of his sewage.

The authority for this assessment is chapter 83, section 16.

> The aldermen of any city except Boston or the sewer commissioners, selectmen or road commissioners of a town, may from time to time establish just and equitable annual charges for the use of the common sewers, which shall be paid by every person who enters his particular sewer therein. The money so received may be applied to the payment of the cost of maintenance and repairs of such sewers or of any debt contracted for sewer purposes.

The constitutionality of the laws in their various phases providing that the benefits may be divided into two or three parts and so assessed have been upheld by the Supreme Court many times. Perhaps the most famous case is that of William H. Carson *v.* Sewerage Commission of Brockton, Mass., 175 Mass. 242, which was carried to the United States Supreme Court in 1901. The courts held the laws to be constitutional, declaring in general: the health of the whole community is benefited by a sewerage system, therefore a part of its cost should be paid by general taxation. When a sewer is laid by a parcel of land, the owner of that land receives a particular benefit, therefore the owner of the land should pay an assessment for this special benefit. Keeping the sewer in operation fit for use is a further special benefit to those who make use of it, therefore an equitable annual charge for its use is just.

The following is a partial list of Massachusetts Supreme Court decisions on various phases of the sewer assessment question:

7 Cush. 277
9 Cush. 233
99 Mass. 627
110 Mass. 433
111 Mass. 123
114 Mass. 546
136 Mass. 179
150 Mass. 12
163 Mass. 23
172 Mass. 28
173 Mass. 350
175 Mass. 242
176 Mass. 247
188 Mass. 81
192 Mass. 287
207 Mass. 123
210 Mass. 151
217 Mass. 422
234 Mass. 108

Assessment of Construction Cost, Maintenance and Operation of Sewerage Districts

The municipalities that comprise the North and South Metropolitan Sewerage Districts in the vicinity of Boston each pay its respective share towards the cost of constructing the systems. The proportion in which each of the municipalities belonging in whole or in part to the district annually pays, to meet interest and sinking fund requirements,

bonds and notes, is based upon the respective taxable valuations of the property of said municipalities. The proportion in which each of the municipalities pays annually to meet the cost of maintenance and operation of the respective sewerage system is based upon the respective populations of said municipalities as ascertained by the last preceding State or National census. The General Laws provide for these divisions of cost and assessments (chapter 92, sections 5, 6, 7 and 8, and amendments thereto).

The municipalities, state and county institutions that comprise the South Essex Sewerage District each pay its respective share toward the cost of construction, maintenance and operation in the following proportion, one third in proportion to their respective valuations and two thirds in proportion to their respective normal average flow of sewage. It is of special interest to note that state and county institutions are members of this district.

Several towns have included the payments made by the town for the cost of construction, maintenance and operation of the sewerage districts in the cost of the local sewerage systems, and then assessed a part of the cost, so construed, of the system upon the land abutting the local sewers. The Supreme Judicial Court has recently handed down the opinion in the case of Annie F. Mullen *v.* Board of Sewer Commissioners of Milton that sewer assessments in Milton which include as part of the cost of a Milton sewerage system the payments toward the cost of construction, maintenance and operation of the South Metropolitan Sewerage District are invalid. The reasons for this decision given in this opinion are of a broad nature and would apply to any city or town included in a sewerage district which includes the district tax as a part of the cost of the local system. As a result of this decision, the towns of Milton, Canton and Danvers have taken steps to change their methods of sewer assessments.

It is common practice to allow the properties abutting a sewer owned by a sewerage district to connect directly with the district sewer. In such cases the city or town in which the sewer is located does not construct a common sewer between the abutting property and the district sewer. However, the city or town levies and collects the usual or special assessment on the abutting property.

Practice in Relation to the Division and Application of Sewer Assessments

The application of sewer assessments in this State being a much mooted matter, our office has been for a number of years interested in obtaining a full list of the facts of sewer assessments in this Commonwealth. To make the list as nearly complete as possible, a specific questionnaire recently has been sent to the remainder of the 118 municipalities that have adopted a system or systems of sewerage. Out of this number there were received 82 replies (of which 2 were in relation to privately owned systems).

A tabulation of the replies is attached, entitled "Sewer Assessments, etc., in Massachusetts."

Thirty-seven municipalities which levy assessments upon the land reported the proportion paid by the city or town by means of the general tax levy for the general benefit due to the construction of sewers. The proportions varied within the legal limits of 25 per cent to 77 per cent, and the average was 41½ per cent, the median being 37½ per cent.

Twenty-three municipalities report that they assess for the specific benefit by means of assessments upon the land by combining an assessment based on area and an assessment based on frontage. The average of that portion of the assessment based on frontage amounts to $0.50 per foot, or 37 per cent of the entire direct assessment, and the average assessment based on area amounts to $0.0082 per square foot, or 63 per cent of the entire direct assessment. The assessment charges per front foot vary from $0.08 to $1.50, and the assessment charges per square foot of area vary from $0.0024 to $0.02. The depth of area assessed varies from 80 feet to 125 feet from the street or way. The average total direct assessment by these 23 cities and towns for a lot with a 75-foot frontage and assessed to the average depth of 108 feet is $94.46, or $1.26 per front foot.

Twenty-one municipalities report that they assess for the specific benefit by means of assessments upon the land based on frontage alone. These assessments vary from $0.40 to $2 per front foot. The average assessment amounts to $1.24 per front foot, or $93 for a lot with 75 feet frontage.

Six municipalities report that they assess for the specific benefit by means of assessments upon the land based on area alone. The average of these assessments amounts to $0.0119 per square foot, and for an average depth of 100 feet is equal to $1.19 per front foot. For a lot with

75 feet frontage and a depth of at least 100 feet, the assessment would equal $89.25.

Thus it is seen that the average charge, whether it be based on frontage and area, frontage alone or area alone, is about the same, and the choice in method of assessment should not be judged so much in relation to the lot which has an average frontage and area, but in relation to the lots whose frontages or areas are unusual. This point has been fully discussed in the report for 1894 of the Sewerage Commissioners upon a sewer tax for the city of Brockton.

These divisions of the specific benefit are provided for in the General Laws, chapter 83, section 15, which reads in part: —

> A city or town may adopt a system of sewerage for a part or the whole of its territory, and may provide that assessments under section fourteen shall be made upon owners of land in such territory by a fixed and uniform rate, based upon the estimated average cost of all the sewers therein, according to the frontage of such land on any way in which a sewer is constructed, or according to the area of such land within a fixed depth from such way, or according to both such frontage and area; but no assessment in respect to any such land, which by reason of its grade or level or any other cause cannot be drained into such sewer shall be made until such incapacity is removed.

Based upon these average assessment charges which are based upon the cost of constructing sewerage systems over a long period of time in this State, it may be said, in a general way, that the average cost of sewer construction has been about $2.12 per linear foot of assessable frontage.

It is general practice, as provided for in chapter 83, section 21, of the General Laws, to exempt a portion of the frontage on corner lots where assessments are based in whole or in part by frontage. These exemptions average about 75 feet.

Section 2 of the Opinion of the Supreme Court in the case of Annie F. Mullen *v.* Board of Sewer Commissioners of Milton is of much interest in regard to corner lot exemptions, etc., and reads as follows: —

> The respondents rightly included in the total cost of the sewerage system the cost of that part of the system in front of non-assessable property, town property, the unassessed side of a corner lot and that part crossing streets. All such sewers needed to be built. They formed a part of the total cost of the system.

In the town of Wellesley, no land which lies below the plane which intersects the top of the inside of the sewer pipe in the street and rises at a grade of 2 per cent from there is assessed. Quincy also has a similar arrangement.

SEWER ASSESSMENTS IN MASSACHUSETTS

MUNICIPALITY	POPULATION 1930 census	Proportional part of Construction Cost finally paid from general tax levy	Assessments on Real Estate: Frontage: Assessment per linear foot	Frontage: Frontage exempted on corner lots	Frontage: Proportion of direct assessment levied by frontage	Area: Assessment per square foot	Area: Distance back from line of way	Area: Proportion of direct assessment levied by area	Assessment on a lot with a frontage of 75 feet with parallel sides extending back to maximum depth assessed	Entrance fee	Rental
Amesbury	11,899	33⅓%	$ 0.50	100 ft.	100%	none	—	none	$ 37.50		
• Amherst	5,888		none	—	—	none	—	—	none	$25.00 per tenement	yes
Andover	9,969		$ 0.50	50 ft.	45%	$.005	120 ft.	55%	$ 82.50		
Arlington [4]	36,094	33⅓%	varies	Second Street sewered	33%	varies	100 ft.	67%	varies		
Athol [10]	10,677	100%	none	—	—	none	—	—	none		yes
• Attleboro [7]	21,769	66⅔%	$ 0.25		varies	$.004	100 ft.	varies	$ 48.75 +		
Belmont [1]	21,748	33⅓%	not to exceed $1.33	50 ft.	100%	none	—	none	not to exceed $187.50		
Beverly	25,086		0.75		50%	$.0075	100 ft.	50%	$ 112.50		
Boston	781,188	varies	not to exceed $ 2.00		100%				not to exceed $ 150.00		
• Brockton	63,797	25%	$ 0.25	60 ft.	40%	$.005	125 ft.	60%	$ 65.62		yes
Brookline	47,490	33⅓%	$ 0.75		50% ±	$.0075		50% ±	$ 112.50 for 100 ft. depth		
Canton	5,816	50%	$ 0.54	75 ft.	40%	$.007	125 ft.	60%	$ 106.12		yes
Cambridge	113,643	25%	$ 0.85		30%	$.02	100 ft.	70%	$ 213.75		
Chelsea [4,8]	45,816	25%	varies	none	100%	none	—	none	varies		
Chicopee [7]	43,930		$ 0.50	longest frontage	varies	none	—	none	varies		
• Clinton	12,817		all over $1.60 per ft.	$ 1.60	smaller frontage	100%	none	—	none	$ 120.00	
Dedham	15,136	50%	$ 0.30		37%	$.004	125 ft.	63%	$ 60.00		
Everett [3]	48,424	50%	not to exceed $ 2.00	60 ft.	100%	none	—	none	not to exceed $150.00		
Fairhaven [2]	10,951	33⅓%	varies		varies	varies	100 ft.	varies	varies		
Fall River	115,274	100%	none	—	—	none	—	—	none	none	none
• Fitchburg	40,692		$ 0.20	100 ft. on second street	17%	$.01	100 ft.	83%	$ 90.00		
• Framingham	22,210	100%	none	—	—	none	—	—	none		yes
• Franklin	7,028	50%	$ 1.00	100 ft.	100%	none	180 ft.	none	$ 75.00		
• Gardner	19,399	none	none	—	—	none	—	—	none	Single ho. $125 2 Family ho. $187.50	
Gloucester	24,204	All from General Tax levy so far									
Great Barrington	5,934	100%	none	—	—	none	—	—	none	$15.00	
Greenfield	15,500	50%	$0.75 maximum	75 ft.	100%	none	—	none	$ 56.25 maximum		
Haverhill	48,710	55%	$ 0.20	largest frontage	18%	$.0075	120 ft.	82%	$ 82.50		
Holyoke	56,537		$ 0.08	one street frontage	12%	$.005	120 ft.	88%	$ 51.00		
• Hudson [11]	8,469	95%	none	—	—	none	—	—	none		yes
Huntington	1,242	100%	none	—	—	none	—	—		yes	
Lawrence	85,068		none	—	none	$.0065	100 ft.	100%	$ 48.75		
• Leominster	21,810		$ 1.00	125 ft. on second street	100%	none	—	none	$ 75.00		
Lexington [5]	9,467	50%	none	—	—	varies	125 ft.	100%	varies		yes
Lowell	100,234		none	—	none	$.01	100 ft.	100%	$ 75.00		
Lynn	102,320		$ 1.00	½ total	100%	none	—	none	$ 75.00		
Malden	58,036		$ 2.00		100%	none	—	none	$ 150.00		
Manchester	2,696	100%	none	—	—	none	—	—	none	none	none
Marblehead	8,668	33⅓%	$ 1.85	½ total	100%	none	—	none	$ 138.75		
• Marlborough	15,587	100%	none	—	—	none	—	—	none		yes
• Maynard	7,156	37½%	$ 1.60	60 ft.	100%	none	—	none	$ 120.00		
• Marion [3]	1,638	66⅔%	none	—	—	none	—	—			yes
Medford	59,714	40% ±	$ 1.50	up to 80 ft. on second street	100%	none	—	none	$ 112.50		
Melrose	23,170	50%	varies	50 ft.	33%	varies	100 ft.	67%	varies		
Methuen	21,069		$ 0.95	½ total	100%	none	—	none	$ 71.25		
Middleborough	8,608		none	—	—	none	—	—	none	$ 25.00	
• Millis [10]	1,738		$ 1.00	½ total	100%	none	—	none	$ 75.00	$ 50.00	
Milton [12]	16,434	not established	$ 1.50	up to 60 ft. on smaller front	50%	$.015	100 ft.	50%	$ 225.00		
Montague	8,081		$ 0.40	up to 110 ft. on second street	100%	none	—	none	$ 30.00		
Nahant	1,654	50%	Rates not yet established					100%			
Natick	13,589	100%	none	—	—	none	—	—	none		yes
Needham	10,845	33⅓%	$ 0.64	60 ft.	39%	$ .01	100 ft.	61%	$ 123.00		
New Bedford [4]	112,000	25%	up to maximum $ 2.00	50 ft.	100%	none	—	none	$ 150.00 maximum		
Newton	65,276	50%	$ 0.30		11%	$ .02	125 ft.	89%	$ 210.00		
North Adams	21,621	100%	none	—	—	none	—	—	none	$ 15.00	
North Andover	6,961		none	—	none	$ .006	100 ft.	100%	$ 45.00		
• North Attleborough	10,197	25%	$ 0.40	60 ft.	100%	none	—	none	$ 30.00		yes
• North Brookfield	3,013	100%	none	—	—	none	—	—	none		
Norwood	15,049	50%	$ 0.44		39%	$ .0068	100 ft.	61%	$ 84.00		
Orange	5,365	100% for extensions	none	—	—	none	—	—	none		
Palmer	9,577	100%	none	—	—	none	—	—	none	$ 25.00	
Peabody	21,345	not established	$ 0.50	up to 80 ft. on second street	100%	none	—	none	$ 37.50		yes
• Pittsfield	49,677	77%	$ 0.90	100 ft.	55%	$ .004	100 ft.	45%	$ 97.50		
Quincy	71,983	50%	$ 0.16		17%	$ .008	100 ft.	83%	$ 72.00 for 100 ft. depth		
Reading	9,767	66⅔%	$ 0.70	60 ft.	100%	none	—	none	$ 52.50		yes
Revere	35,680	varies	$ 0.50	longest st. frontage with exceptions	abt. 50%	$ .005	100 ft.	abt. 50%	$ 75.00		
Somerville [8]	103,908	50%	varies	none	100%	none	—	none			
Springfield	149,900	varies	$ 0.50	100 ft.	50%	$ .005	100 ft.	50%	$ 75.00	yes	
Swampscott [6]	10,346	50%	abt. $1.50		100%	none	—	none	abt. $112.50		
Taunton	37,355	33⅓%	$ 0.20	60 ft.	40%	$ .0024	125 ft.	60%	$ 37.50		yes
Wakefield	16,318	33⅓%	$ 0.75	up to 80 ft. on second street	53%	$ .0175	80 ft.	47%	$ 161.25		
Waltham	39,247		$ 0.75		50%	$ .0075	100 ft.	50%	$ 112.50		
Watertown	34,913	100%	none	—	—	none	—	—	none		
Webster	12,992	25%	varies						varies		
Wellesley	11,439	25%	$ 0.20	70 ft.	29%	$ .004	125 ft.	71%	$ 52.50		yes
Westfield	19,775	100%	none	—	—	none	—	—	none	Single ho. $15 2 family ho. $20	
Winchester [9]	12,719	33⅓%	abt. $1.60	75 ft.	100%	none	—	—	abt. $120.00		
Winthrop	16,852	33⅓%	none	—	none	$ .007	100 ft.	100%	$ 52.50		
Woburn	19,434	100%	none	—	—	none	—	—	none		yes
• Worcester	195,311	none	none	—	—	$ .03	100 ft.	100%	$ 225.00		

• Have sewage disposal areas.

1. In Belmont all the new developments pay the entire cost of the sewers.
2. The system was given to the town. The town pays ⅓ of the cost of extensions.
3. Applies to original system only. Municipality pays for extensions.
4. Assessment varies for each sewer constructed.
5. Abutters pay 50% of cost of sewer, based on the average cost of the sewers constructed during the previous 5 years. Also have rental system, charge = ½ of water bill.
6. All the sewers built in one year are proportioned to the frontage sewered that year.
7. Also 2½% on valuation of land only abutting sewer in Attleboro. Also 1% of valuation of land and buildings in Chicopee.
8. Applies to each individual extension, adjustments are made where trunk sewers are built so that assessments will not exceed assessments of ordinary extensions.
9. Assessment based on average cost of sewers for the previous 5 years.
10. Town raised money to augment rental receipts during first few years. Extensions are in general paid for by the town.
11. Property owners guarantee 5% of cost of extending sewer. When sewer rates equal the 5% guaranteed, the obligation has been fulfilled and then they pay only the sewer rates.
12. Rate etc. declared illegal by court.

Tabulation of replies to questionaire sent out by WHITMAN & HOWARD, CIVIL ENGINEERS.
Compilation by Paul F. Howard, M.S.

Most municipalities assess the entire lot if a building reasonably built on it may be connected with the sewer. In general, the practice is to assess the area and frontage of the whole lot, or a reasonable house lot in cases of larger tracts, where the sewer is available but does not extend by the entire frontage of a lot.

Ten municipalities report that they assess the specific benefit wholly or in part by means of an entrance fee, and Springfield assesses it in part by an assessment on the land and in part by an entrance fee. Attleboro assesses it in part by an assessment on the land and in part by an assessment equal to 2½ per cent of the value of the land, the land only. Chicopee assesses it according to the frontage of the lot plus 1 per cent of the value of the land and buildings.

The attached table shows the ten municipalities charging fees and their amounts. The average entrance fee for a single house is $35 for those municipalities which make no other charges than the entrance fee. The maximum charge is $125 and the minimum, $15.

The attached table shows the *annual* charges made by 17 Massachusetts municipalities, 12 of which are based upon water consumption and 5 upon flat rates. The rates based upon water consumption vary from 25 per cent to 100 per cent of the charges for water in the respective municipalities. The flat rate charges vary from $2.50 to $8 a year per tenement.

Six of the municipalities report that the entire cost of construction was paid in the first instance by means of the general tax levy, and that the annual charges were enough to pay for the maintenance and operation of the system, and in some cases to pay for a part of the construction cost.

The town of Watertown pays by means of the general tax levy the entire cost of constructing, maintaining and operating its sewerage system. The town so voted in 1892, and in 1893 the Legislature declared the town's action legal and authorized the town to continue to pay the entire cost of laying, maintaining and repairing its common sewer.

The town of Belmont requires the owner of a tract of land which has been subdivided into lots to construct and pay the entire cost of the sewers within the said tract. The town paid about one third of the cost of the original common sewers and those that are necessary, as outlets, etc. General Laws, chapter 83, section 22, authorizes in a general way this method of distributing the cost.

It is the practice to make so-called "sewer assessment plans" and to record the same with the town clerk or in any other office of the town which the town may determine. A few municipalities also record these

plans in the Registry of Deeds. The plans usually show the location of the sewer and its branches, together with its grade, by means of a profile. The areas or frontages or both that are assessed are also usually shown on these plans, together with the location of buildings. Some towns incidentally show on the profiles the location of all ledge and the character of the soil excavated and the ground water level. General Laws, chapter 83, section 2, provides that such plans and descriptions, together with records of cost, shall be kept in a town office, etc.

Whenever sewer assessments are to be levied, the law provides that a statement shall be recorded in the Registry of Deeds specifying the ways and locations in which the sewers are to be built. Some municipalities file location plans with these statements.

Financing the Construction of Sewerage Systems

Debts contracted for sewer purposes are included within the 3 per cent debt limit for cities and towns. Many special acts which are mostly repetitions of the General Laws have been written for the construction of sewerage systems, of which the principal object was to secure permission to contract the debt outside of the general debt limit. The laws provide that money may be borrowed by means of serial notes over a period of thirty years for the construction of sewerage systems and sewage disposal works.

Chapter 377 of the Acts of 1923 provides that an abutter may have his specific assessment divided into ten equal annual payments, and that he must pay to the municipality 6 per cent interest per annum on the unpaid balance. Since the city or town generally borrows its money for about 4 per cent, the city or town gains about 2 per cent on the unpaid balances. In times of normal business conditions, about one half of the assessments are paid in full within the first year after the assessments are levied. Since a municipality may borrow temporarily for one year, if it builds a system of sewers and levies the assessment within one year after first borrowing, they need only issue notes for the cost of the sewerage system minus the assessment charges paid in, and minus 25 cents per $1,000 of valuation of the city or town. The law requires that this 25 cents per $1,000 valuation must be put into the general tax levy for each loan made for sewer purposes.

Particular Sewers

It is the custom in Massachusetts cities and towns for the abutter to pay the entire cost of constructing the particular sewer or house connection that connects his property with the common sewer.

Particular sewers or house connections are usually constructed and financed by one of the following methods:

Some municipalities license drain layers, *i.e.*, certain reputable contractors, to lay particular sewers or house connections from the common sewer to the building to be sewered. The parties licensed are generally required to furnish a surety bond guaranteeing that they will do the work in a satisfactory manner, make the street safe, etc. Under this method, the party desiring to have his building connected with the common sewer employs a licensed drain layer and makes his own contract with the drain layer to do the work; the municipality does not enter into the contract. When this method is employed, the work should be thoroughly inspected by an agent of the city or town.

Other municipalities lay particular sewers or house connections themselves upon application of the owner of the property to be sewered. The material is generally purchased by and the work done by the sewer department. Where this method is employed, it is necessary for the municipality to make an appropriation for particular sewers. The city or town may require that the party for whom the particular sewer is being constructed shall pay the estimated cost of the sewer in advance, or the town may construct it and send a bill for the work done. If the bill is not paid within a certain proper time, the cost of the house connection may be assessed upon the property benefited. If the cost is assessed, the party owning the property upon which the assessment is made may apply to the assessors to have the cost apportioned in equal annual payments over a period not exceeding ten years. Interest at 6 per cent per annum after thirty days of the date of the bill for the work done is charged on all unpaid balances.

Municipalities may construct particular sewers or house connections from the common sewer to the boundary of the way and assess each property connected in proportion to the estimated average cost of all the particular sewers within the territory for which a system of sewers has been built. This latter method has not been generally used. Chapter 83, sections 3 and 24, of the General Laws provides for the construction of particular sewers or house connections.

Sewer Rental Charges in Massachusetts

I. Charges Based upon Metered Water Consumption

Brockton — $0.15 per 100 cubic feet of water consumed per quarter.

Canton — $0.12 per 100 cubic feet of water, or two thirds of water bill. Minimum charge of $4 per year. Unmetered service, $4 per year.

Framingham — $0.0875 per 100 cubic feet of water up to 10,000 cubic feet, and for larger amounts a rate down to $0.035 per 100 cubic feet is made. Minimum charge of $2.10 per year. These charges equal about 35 per cent of the charges for water.

Hudson — $0.25 per 100 cubic feet of water. If prompt payment is made there is a discount of 25 per cent. The minimum charge is $6 per year.

Lexington — $0.075 per 100 cubic feet of water, with a minimum annual charge of $3.75. Sliding rates for larger users, $0.075 to $0.045 per 100 cubic feet. Rates equal 25 per cent of water bill.

Marlborough — $0.075 per 100 cubic feet of water, with a minimum annual charge of $4. If the water supply is not metered an annual charge of $6 is made.

Natick — $0.25 per 100 cubic feet of water, with a $6 minimum charge. These charges are equal to the charges for water.

North Attleborough — $5 per year minimum charge for 25,000 gallons of water.

Peabody — $0.0375 per 100 cubic feet of water. These charges equal about 25 per cent of the water bill.

Reading — $0.23⅓ per 100 cubic feet for first 4,000 cubic feet; $0.20 per 100 cubic feet for second 4,000 cubic feet; $0.16⅔ per 100 cubic feet for third 4,000 cubic feet; $0.13⅓ per 100 cubic feet for next 10,000 cubic feet; $0.10 per 100 cubic feet for all over 22,000 cubic feet. All over $300 at rate of $0.03¾ per 100 cubic feet. Unmetered service, $6 per year.

Wellesley — $0.185 per 100 cubic feet is charged for all in excess of 2,200 cubic feet per year. These charges are equal to those for water. Minimum annual charge of $6 per year is made.

II. Charges Based upon Flat Rates

Amherst — $3 per year per tenement.

Athol — $3 per year per tenement.

Marion — $2.50 per fixture, not including lavatories.

Taunton — $2.50 per year minimum. Flat rates per tenement.

Woburn — $8 per tenement; $25 per public hall, etc.; $2.50 per office; $5 per store.

Sewer Entrance Fees in Massachusetts

Amherst — $25 per tenement.

Gardner — $125 per single house built for a single family on the ground floor (lot not to exceed 100 feet frontage); $62.50 for each additional family. $250 per double house built for two families on the ground floor (lot not to exceed 100 feet frontage); $62.50 for each additional family. $25 for a store not exceeding 30 feet frontage. $6.25 for each employee in a factory. $6.25 for each scholar in a school.

Great Barrington — $15 entrance fee.

Huntington — Charge an entrance fee.

Middleborough — $25 entrance fee.
Millis — $50 entrance fee.
North Adams — $15 entrance fee.
Palmer — $25 entrance fee.
Springfield — Single dwellings, $65. Two-family dwellings, $80. Factories, stores, etc., $0.03 per square foot of area covered by the building for the lower two stories and $0.0075 per square foot of area covered by the building for each additional story, provided that no entrance fee shall be less than $75. Wherever an assessment has been paid on account of sewer construction, the amount of the entrance fee shall be reduced by said sewer assessment.
Westfield — $15 per single house. $20 per two-family house.

THE FALLACY OF THE MIDDLE THIRD THEORY

Samuel Shulits, Hydraulic Engineer,* Cambridge, Mass.

It was hitherto generally assumed in dam design that tensile stresses could not occur at the upstream face of a dam, where they are most dangerous, if the resultant did not pass beyond the limits of the middle third of the profile. N. Kelen† and A. Schoklitsch‡ have shown that

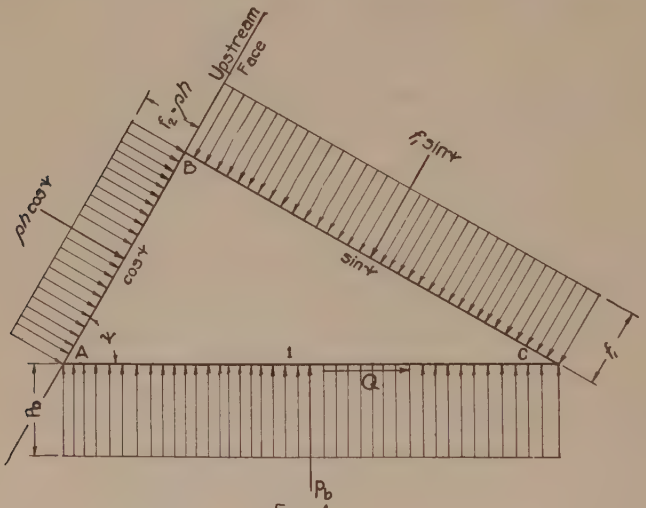

Fig. 1

this is not true. The proof is quite simple and is based on the consideration of the principal stresses at the upstream face of the dam.

Consider an infinitesimal, horizontal, triangular prism (Fig. 1), of length one, at the upstream side of the dam. One of its sides, AB, is a part of the upstream face; the second, BC, is perpendicular to AB; while the third, AC, is horizontal and has a length of one. Let ψ be the

* Former John R. Freeman Traveling Fellow of the Boston Society of Civil Engineers, 1929–31, in European Hydraulic Laboratories, and engaged at the direction of the late Dr. Freeman to continue foreign special research work in 1932–33.

† "Die Staumauern" (Masonry Dams).

‡ "Der Wasserbau" (Hydraulic Structures), which has been translated into the English language by the writer under the auspices of the late Dr. John R. Freeman and the Massachusetts Institute of Technology.

angle which the upstream face makes with the horizontal. The length of AB and BC are, accordingly, $\cos\psi$ and $\sin\psi$, respectively.

The unit stress on AB is the second principal stress, f_2, and the total force acting on this face is $f_2 \cos\psi$. But f_2 is equal to ρh where ρ is the unit weight of water and h is the distance of the prism below the water surface. Therefore, the total force acting on AB is $\rho h \cos\psi$.

Since BC is perpendicular to AB, it is a plane of principal stress, and the stress on it is the other principal stress, f_1. The total force acting on BC is $f_1 \sin\psi$.

The unit stress on AC is the vertical normal pressure, p_b, at the upstream face and the total force on AC is p_b (1).

For equilibrium of the prism the sum of the moments of all forces acting on it about any point, *e.g.*, A, must be zero. Therefore —

$$\rho h \cos\psi \frac{\cos\psi}{2} + f_1 \sin\psi \frac{\sin\psi}{2} - p_b \frac{1}{2} = 0 \qquad (1)$$

$$\rho h \cos^2\psi + f_1 \sin^2\psi - p_b = 0 \qquad (2)$$

or

$$f_1 = \frac{p_b}{\sin^2\psi} - \rho h \cot^2\psi \qquad (3)$$

As is evident from equation (3), the principal stress, f_1, can become negative, *i.e.*, be a tensile stress, even when p_b is positive, or, in other words, a compressive stress. This can happen when —

$$\frac{p_b}{\sin^2\psi} < \rho h \cot^2\psi \qquad (4)$$

or

$$p_b < \rho h \cos^2\psi \qquad (5)$$

If, *e.g.*, $p_b = 0$ and the upstream face is not vertical, *i.e.*, $\cos^2\psi \neq 0$, the principal stress, f_1, will be tension. The condition, $p_b = 0$, signifies, however, nothing more than that the resultant of the external forces passes through the downstream boundary of the middle third of the horizontal joint. Therefore, fulfillment merely of the usual requirement that the line of resistance shall remain within the middle third will not ensure the non-occurrence of the tensile stresses; the line of resistance must also be as far from the downstream edge of the middle third as is necessary for p_b to be larger than $\rho h \cos^2\psi$.

The well-known graphical method (Fig. 2) for determining the distribution of stress along the joint of a dam can also be used for determining where the resultant must lie in order to satisfy the condition that p_b be greater than $\rho h \cos^2 \psi$. Fig. 2 is self-explanatory.

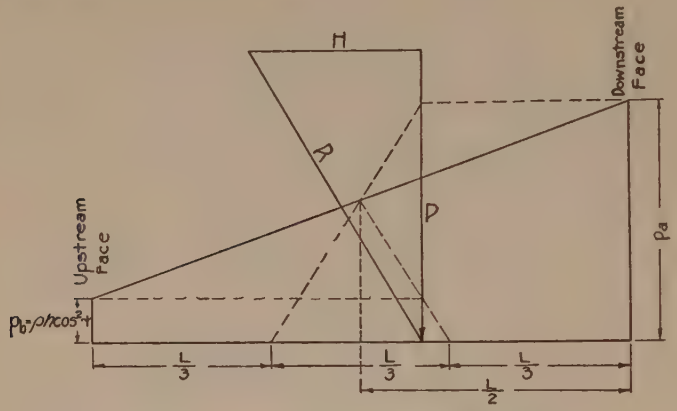

FIG. 2 GRAPHICAL CHECK OF FULFILMENT OF CONDITION THAT $p_b > \rho h \cos^2 \psi$

Of General Interest

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETINGS

Northeastern Section

May 4, 1933 — The Northeastern University Section of the Boston Society of Civil Engineers had a luncheon at the Amo Restaurant, where the guest of the occasion, Prof. Charles B. Breed, entertained the group with many humorous stories of his experience and bits of his own philosophy.

The regular annual meeting was held at 7.30 o'clock in Room 18-H. The business of the meeting was the election of officers for the coming year.

Anthony Tedesco and Whelan Crouch were nominated for president. Anthony Tedesco, who was president last year, was re-elected.

Rolf Hamstrom, Rahn Bauer and Walter Butler were nominated and elected to the Executive Committee. Bruce Schow was retained as Clerk.

Prof. Charles B. Breed, Massachusetts Institute of Technology, talked on the "Lucerne Project in Quebec," for which he is acting as consulting engineer. Numerous photographs and plans gave his listeners a clear picture of the scope and beauty of the undertaking, which is virtually a "Rich Man's Paradise."

In his informal lecture Professor Breed stressed the importance of a liberal education for the civil engineer. From his own experience he showed how necessary it was for an engineer to think and act quickly in new and unusual situations.

Bruce Schow, *Clerk.*

DEATH

Louis K. Rourke . August 23, 1933

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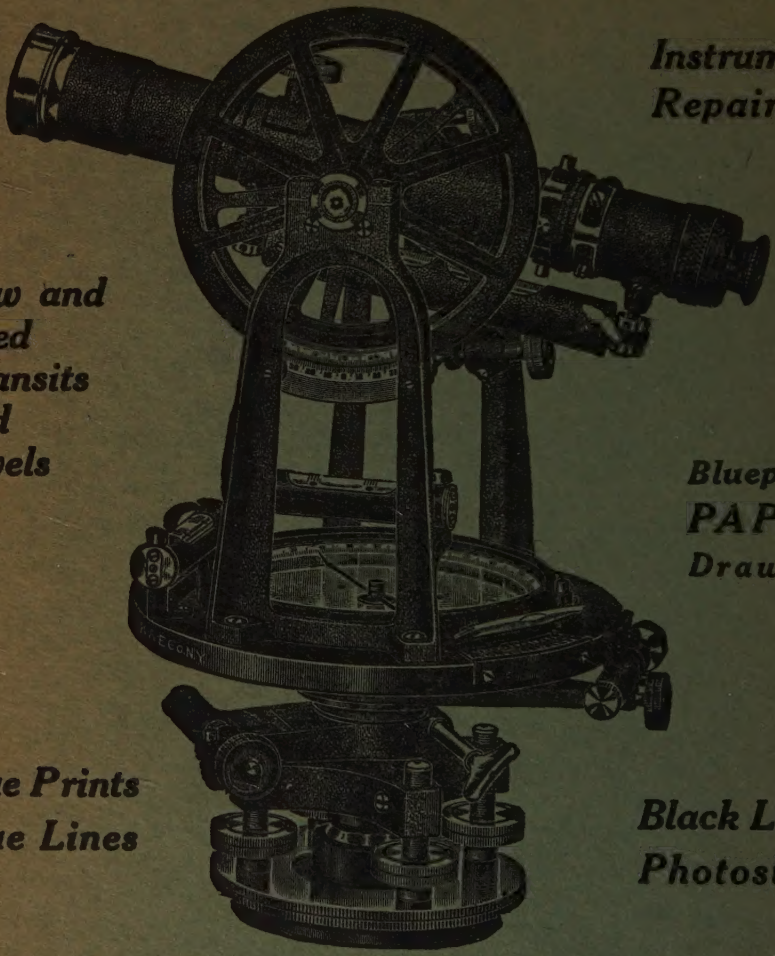

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